Hiatella solida (Sowerby, 1834)

(Mollusca : Hiatellidae)

on *Concholepas concholepas* (Bruguière, 1789) and other Substrates

BY

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(3 Text figures)

INTRODUCTION

THE ABILITY TO PERFORATE hard substrates has evolved independently in different groups of bivalves. In species of the genus *Hiatella* this specialization was probably assumed after initial life as byssally attached nestlers (YONGE, 1964). The primitive byssiferous nestler characteristic is still present in *Hiatella gallicana* (Lamarck, 1818) and in *H. arctica* (Linnaeus, 1767), according to HUNTER (1949). Members of a single species may reveal other fixation behavior determined by the substrate. On a hard but creviced rock surface, the spat nestle, using the byssus, and those settling on a smooth rock surface of a soft, homogenous rock will move about until they find a crevice wherein to bore. HUNTER (*op. cit.*) points out that the byssus is absent in boring individuals.

According to NARCHI (1973) and to data compiled by CARCELLES (1944), *Hiatella solida* uses both behavioral patterns to place itself securely in the substrate. In Brazil, NARCHI (1973) reports that individuals use the byssus to fix themselves to the sea-squirt *Polyandrocarpa zorritensis*, among tubes of the polychaete *Phragmatopoma lapidosa*, or under clusters of the bryozoan *Zoobotryon pellucidum*. They have also been found boring or nestling in the intertidal zone. According to CARCELLES (*op. cit.*), in Argentina the species lives on rocky sea-beds in inter- or subtidal zones, boring the sandstone or incrusted in bivalve or gastropod shells.

There is very little in Chilean literature on habitat or relationship of the different substrates. SOOT-RYEN (1959) states that *Hiatella* occurs on hard sea-beds from the intertidal zone to depths of 70 m. MARINCOVICH (1973) found it nestling in crevices of intertidal rocks as well as on holdfasts of the kelp *Lessonia nigrescens* Bory, 1825. Its geographic range is rather extensive, from South Ecuador to Cape Horn,and in the Atlantic its northern limit is the southern part of Brazil. This paper provides information on occurrence in southern Chile, especially the association with the gastropod *Concholepas*.

MATERIAL AND METHODS

Two collections of adult *Concholepas concholepas* (Bruguière, 1789) (Table 1) as well as sporadic samplings of *Fissurella nigra* (Lesson, 1830) and the tunicate *Pyura chilensis* (Molina, 1782) were made. Samples were obtained by scuba-diving in the south bank of the entrance to Corral Bay (39°51'S; 73°27'W).

Specimens of *Concholepas* were kept in aquaria, where the presence of *Hiatella solida* was revealed by their projecting siphons. To remove the bivalve, the shells of the *Concholepas* were gradually broken up. Notes were taken on the size of the bivalves, their location, and their relation with the accompanying epibiontic community. Macroscopic sections of *Concholepas* shells showed the shape of the excavations and the position of the *Hiatella* within.

Other substrates on which *Hiatella solida* occurs were also studied: *Megabalanus psittacus* (Molina, 1782), bought at the market in Valdivia on October 26, 1975; intertidal samples of *Phragmatopoma virginii* Kinberg, 1867, and holdfasts of the kelp *Lessonia nigrescens* obtained in Mehuin Bay (39°25′S; 73°10′W) on April 15, 1976.

Descriptions by Olsson (1961) and Dell (1964) were used for the identification of the *Hiatella*, the identification being later confirmed by Dr. Myra Keen.

RESULTS

Hiatella solida was found as an incrustive epibiont in the calcareous shells of *Concholepas concholepas* from Corral Bay (Table 1); on *Fissurella nigra* from among the kelp *Durvillaea antarctica* (Chamisso) (obtained with scubadiving by Col. C. Moreno on May 5, 1975), and on *Megabalanus psittacus.*

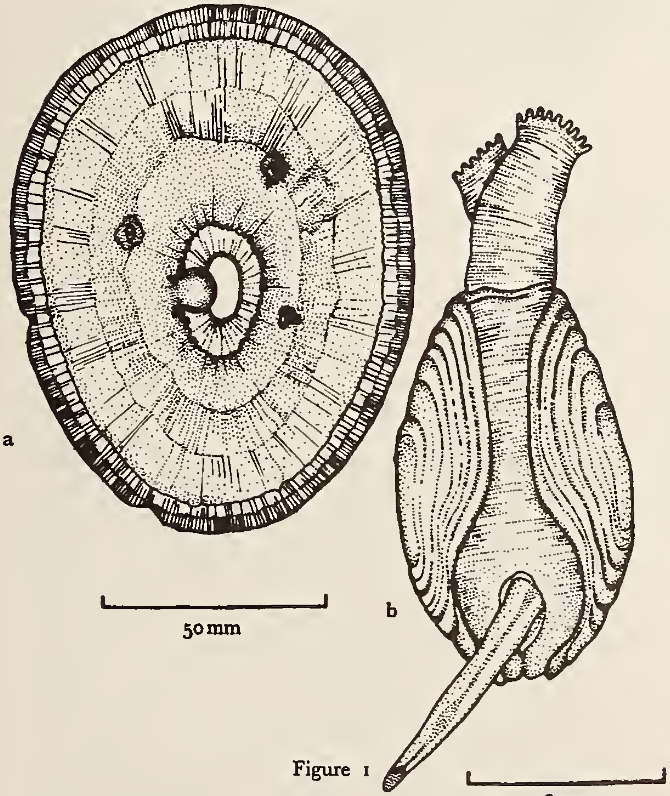

Figure 1

Hiatella solida

A. – Incrustive manifestations of the bivalve as seen from the inside of a *Fissurella nigra* shell
B – Ventral view of *Hiatella solida*

On a *Fissurella nigra* specimen measuring 11.6 cm in length, 9 cm in width, 4 *Hiatella* specimens occurred. Three of them were on different parts of the shell, with an oblique orientation to the surface. Their lengths were 11.5, 6.4, and 6.2 mm, respectively. The 4^{th} specimen was 9 mm long and was next to the apical foramen in a mound formed by the internal layers of the shell (Figure 1A). Both the periostracum and the middle layers of the *Fissurella* were seriously damaged by several tubiculous polychaete tunnels. A specimen of *Hiatella* measuring 27 × 14 mm was found to have incrusted the base of a *Megabalanus* shell.

In sublittoral samples of the colonial tunicate *Pyura chilensis* in Corral Bay, the *Hiatella* nestled in the interstices between individuals. It forms part of the *Pyura* community, along with other bivalves such as *Hormomya granulata* (Hanley, 1843), *Lyonsia fretalis* Dall, 1915, *Aulacomya ater* (Molina, 1782), and *Mytilus chilensis* Hupe, 1854, cited by Zamorano & Moreno (1975). However, *Hiatella* was absent in intertidal samples of *Pyura chilensis*, *Phragmatopoma virginii*, and *Lessonia nigrescens* from Mehuin Bay.

EPIBIOSIS on *Concholepas*

The frequency with which *Hiatella solida* acts as an incrustive epibiont on *Concholepas* is variable, as can be seen in Table 1. It may also be noted that on a single shell both juveniles – the smallest measuring just over 2 mm – and adults of different sizes may occur. The largest adult specimen studied was 17 mm long. The bivalves lie in their burrows approximately perpendicular to the surface, with the posterior end directed toward the external opening (Figure 2A). Some individuals assume a more oblique position, thus attaining greater length without perforating the inner layer (Figure 2B). However, no matter which is the orientation, larger specimens may reach the inner layer. At such points, the shell material takes on a yellowish-brown color and is fibrous and brittle. In high density areas individuals are very close together and 2 or more burrows may come to communicate with each other as individuals grow. In a $9 cm^2$ area, 10 medium and large sized individuals were counted. One specimen was byssally attached to its excavation by a single thread. Hunter (1949) observed in *Hiatella gallicana* and *H. arctica*, a single byssus thread is used, but rarely by borers, to alter their position in the burrow.

There seems to be no direct relationship between the frequency of bivalve occurrence on *Concholepas* and the size of the gastropod shell. Mostly, presence on the shell is closely related to the developmental stage of the epi-

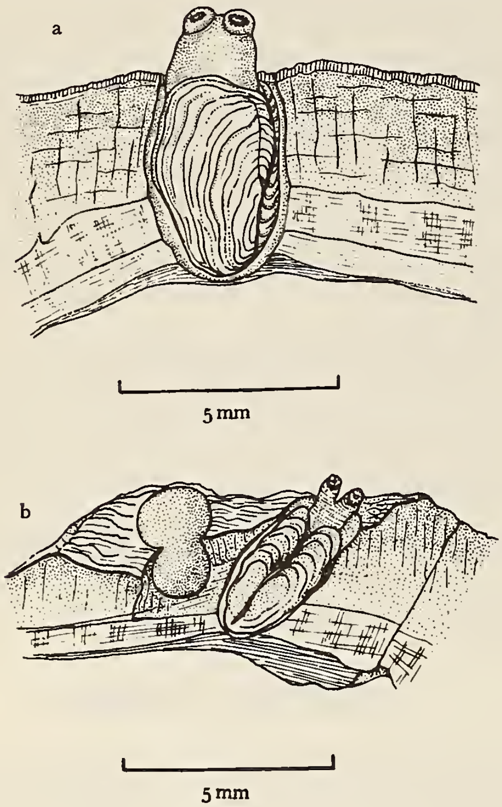

Figure 2

Hiatella solida

A – *Concholepas concholepas* shell section showing an adult bivalve incrusted perpendicularly
B – Section showing the bivalve in an oblique orientation

biontic community (see Table 1). Specimens of *Hiatella solida* are frequently found on shells with large numbers of tubicolous epibiontic polychaetes, calcareous seaweeds, and empty dead barnacle shells, or among abundant phoronids. These seem to be the most important in helping the *Hiatella* to bore successfuly, especially on the less protected faces of the substrate. Several juvenile and medium sized bivalves with siphons projected were found inside empty shells of *Balanus flosculus* Darwin, 1854, and *B. laevis* Bruguière, 1789 (Figure 3). This indicates that the bivalve first entered the shell, then became a burrower. Being small, it had been capable of going through the narrow opening. A similar habitat was reported for *Hiatella* by Hunter (1949) – non-boring adults byssally attached inside empty shells of large barnacles. Some parts of the gastropod shell were eroded either by mechanical or by abrasive agents, leaving the *Hiatella* partially exposed or even completely dislodging it from the shelter (Figure 3). Incrustive juvenile bivalves may often be found at the umbo or in adjacent areas

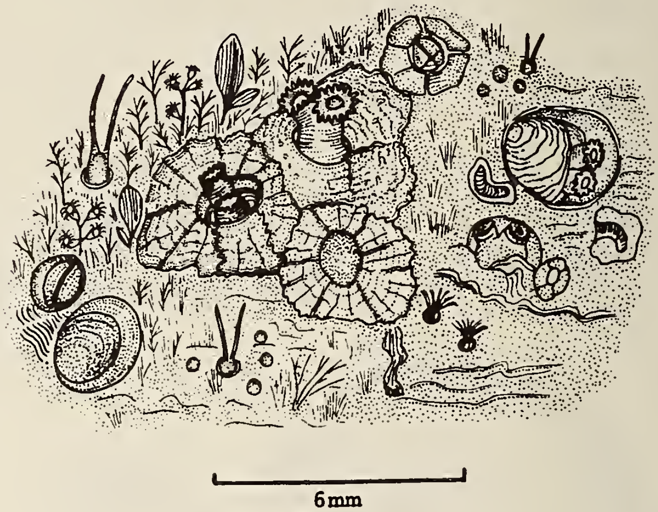

Figure 3

Hiatella solida

Surface view of *Concholepas concholepas* shell with *Hiatella solida* and other incrustive epibionts. Young specimens of *Hiatella solida* are observed inside empty dead barnacle shells

eroded by tubiculous polychaetes of the family Spionidae or by abundant *Phoronis ovalis* Wright, 1856, as epibionts. The incrustive worms therefore play an important part in preparing an adequate substrate for *Hiatella* to bore in.

Gastropod shells with only a few epibionts do not afford the bivalves adequate conditions for quick penetration. Then the Hiatellas are restricted to the crevice on the left side of the *Concholepas* shell, under the umbo, where attachment is usually by a byssus. Hiatellas using this shelter, especially large individuals, bore deep burrows, possibly to avoid exposure as they grow. The corrosion carried on by other burrowers greatly aids *Hiatella* with its boring. Some other filtering epibionts also colonize the area, the most important being *Verruca laevigata* (Sowerby, 1827), bryozoans, and some sea-squirts.

Table 1

Incidence of *Hiatella solida* and other epibionts on *Concholepas concholepas* shells from Corral Bay (11/10/74 - 1/4/76)

Diameter of *Concholepas concholepas*	Epibionts									
	Hiatella solida	Polychaete tunnels	*Spirorbis* sp.	*Phoronis ovalis*	Bryozoa	*Balanus flosculus*	*Verruca laevigata*	*Balanus laevis*	*Chthamalus scabrosus*	Calcareous algae
63 mm	3	++	–	–	++	–	++	–	–	–
96	–	–	×	–	×	–	–	–	–	–
98	3	++	×	–	–	–	–	–	–	–
99	3	++	–	–	–	+	–	–	–	–
100	–	×	×	–	×	–	–	–	–	–
102	–	+	–	–	–	+	–	+	–	–
102	–	–	–	–	–	++	–	–	–	×
103	–	×	–	–	–	+	–	–	–	–
103	3	+	+	–	–	+	–	–	–	–
104	16	++	++	–	–	++	–	–	–	++
105	4	++	–	–	–	++	–	–	++	++
105	–	+	–	–	–	–	–	–	–	–
107	5	–	–	++	–	++	–	–	–	–
108	–	–	+	–	–	+	–	–	–	–
110	9	++	–	–	–	–	++	–	–	–
110	–	–	–	–	++	–	++	–	–	–
112	1	++	–	++	–	–	–	–	–	–
112	–	+	–	–	–	–	×	×	–	–
120	1	++	–	–	–	++	–	++	–	–
123	4	–	–	++	–	–	–	–	–	–
125	28	++	–	–	–	++	–	–	–	++

++ = abundant; + = scarce; × = presence.

DISCUSSION

Hiatella solida is a nestler, using the byssus to fix itself among colonies of the tunicate *Pyura chilensis*, in intertidal crevices, in *Lessonia nigrescens* holdfasts in northern Chile (Marincovich, 1971), or in the sea-squirts *Polyandrocarpa zorritensis* and *Phragmatopoma lapidosa* on the coasts of Brazil (Narchi, 1973). The ability to perforate certain substrates and gastropod shells, mentioned briefly by Carcelles (1944), is confirmed here by observations on *Concholepas concholepas* and *Fissurella nigra*. It can bore not only in the calcareous shells of mollusks but also in those of other invertebrates, such as *Megabalanus psittacus*.

The nestling or boring behavior is determined not only by the hardness of the substrate but also by whether there are adequate shelters – cracks or crevices – in which to nestle. These shelters seem to be required for attachment on hard, impenetrable substrates or in intertidal rocks (Marincovich, 1973). Thus, the species never prospers in impenetrable hard substrates with homogeneous areas lacking shelters. These conclusions also seem to apply for *Hiatella gallicana* and *H. arctica*. Substrates with plenty of safe shelters for permanent nestling would be those offered by such sea-squirt colonies as *Phragmatopoma*, *Lessonia nigrescens* holdfasts, and probably some others. *Concholepas* affords *Hiatella solida* shelter and crevices on a transitory basis. Neither the chink under the umbo of the *Concholepas* or the empty cirriped shells attached on it offer *Hiatella* a safe shelter on which it can grow without becoming exposed. However, these shelters are vital in helping the bivalve to bore into the shell successfully. Empty barnacle shells play an essential role. Moreover, abrasion and burrows of other incrustive epibionts such as polychaetes and *Phoronis ovalis* seem to be prerequisites for successful boring into the substrate.

The calcareous shells of *Megabalanus psittacus* apparently offer the *Hiatella* an unsafe substrate for byssal fixation alone. Besides being easy prey for possible predators while so attached, the bivalves must also undergo the same abrasion as the *Concholepas*, especially when the gastropod enters into cracks and crevices of the hard substrate. The fact that the valves of *Hiatella solida* close partially, leaving the ventral side exposed, seems to indicate that the species is adapted to life only inside shelters in the substrate.

As Yonge (1962, 1964) postulated, the boring habit of *Hiatella* in calcareous shells as well as in other substrates can be considered to have developed subsequently to the nestling habit and byssal fixation in benthonic shelters. Adopting the boring habit seems to be an important step toward the colonization of penetrable substrates that are open and homogeneous and therefore not suitable for long-time nestling.

Assessment of the damage that incrustive epibionts cause on *Concholepas* shells is scanty. Only Arenas (1972) gives information on the effect that *Phoronis ovalis* has on the gastropod. It has been observed that large specimens of *Hiatella solida* can penetrate even the inner layer. However, no manifestations of layer thickening were apparent at the affected points, though this occurs with massive incrustations of *Ph. ovalis*. The effect of *H. solida*, though damaging, is local and secondary, almost always following incrustations of polychaetes and *Phoronis*. A similar situation seems to occur in *Fissurella nigra*. In one specimen, shown in Figure 1A, the mound around the incrustive bivalve may possibly be a defense used when the penetrator endangers vital functions. No such response was apparent in other areas of the shells that were affected by *H. solida*.

In systematic studies of *Hiatella solida* Soot-Ryen (1959) distinguishes two forms and Dell (1964) observed variability in form and shape in specimens from the East Coast of South America and the Magallanes region. This variability, which has probably led to the series of names for the species, could be caused by the types of surface on which they settle.

In studies carried out on epibionts in *Concholepas concholepas* from Caleta Leandro (36°39′S; 73°05′W) *Hiatella solida* was not found (Lozada *et al.*, 1976).

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